The noise impact on residential environments in contemporary metropolises: the case of Barcelona.

Carlos Marmolejo Duarte & Josep Roca Cladera

Centre of Land Policy and Valuations

Polytechnic University of Catalonia

Abstract

Environmental noise is one of the main prices that modern societies have to pay for living in densely urbanized areas. The noise impact on people's quality of life goes beyond annoyance, and may affect somatic and psychic aspects of health. Environmental economics is the theoretical framework supporting instruments designed to evaluate the impact of noise on peoples' quality of life. Namely, such instruments are based on the revealed and stated preferences of users, in this case citizens. In this paper, the results of two stated preference studies are presented. The aim of both researches is to assess the impact of noise on residential environments. The first research analyzes the residential area affected by the enlargement of the Barcelona's international airport, meanwhile the second deals with noise assessment in the central area of Barcelona. Results suggest that willingness to pay (WTP), for offered noise reduction, average 8.95 Euros/person/month in the airport case (equivalent to restoring the noise to the level registered before enlargement). In the case of noise at urban center WTP averaged 3.39 Euros/person/month (for improving rush-hour environmental noise levels to that experienced at 9.00 pm). Econometric analysis of responses allows detecting whether or not WTP can be explained by noise nuisance and other social and environmental factors.

Key words: noise assessment, airport noise, environmental economics, contingent valuation.

Introduction: Barcelona a compact and noisy city.

Recently Barcelona's has been recognized as a compact, diverse and Mediterranean metropolis. Such urban features are considered as positive, since they improve the quality of life of citizens, by means of reducing the potential commuting, using intensively the public space and servicing the residential neighborhoods. Nonetheless, compact cities, are also, dense cities, both in residential and pedestrian terms. According to the penultimate noise map of Barcelona 76.6% of the evaluated areas are above 65 dBA during the day; meanwhile at night there are 91.5% (see table 1). The ODCE has suggested that above such a threshold the impact of noise on people may be severe, since it may affect the behavior and health (García & Garrido, 2003). Therefore noise annoyance is the prices to be paid for living in compact cities.

Table 1 Noise nuisance at Barcelona 1997

Day noise level	Night noise level	Annoyance tolerance	% measured areas (day)	% measured areas (night)
< 65 dB	< 55 dB	Hig	23,4%	8,5%
65 a 75 dB	55 a 65 dB	Medium	63,8%	54,3%
> 75 dB	> 65 dB	low	12,8%	37,2%
			100,0%	100,0%

Source: noise map (Barcelona's City Council, 1997)

At a metropolitan level most severely affected areas by urban noise are, besides Barcelona municipality, the densest municipalities of the central conurbation. But also other areas affected by specific noise sources like the coastal residential area surrounding the Barcelona's international airport (El Prat) recently upgraded. In this paper we report the main findings of two researches that try to assess the impact of general noise in Barcelona's municipality, and in the surrounding areas of Barcelona's airport respectively. Such researches have been carried out in the context of the Master in Urban Land Management and Valuations of the Polytechnic University of Catalonia, namely in the environmental assessment course.

The paper continues as follows: first the theoretical framework and the methodology are exposed, after the findings for the airport enlargement are detailed, as well as the details for the Barcelona's centre are reported. The paper ends discussing the main conclusions of the research.

1. Revealed and stated preferences as a way to assess the noise impact on quality of life

Noise impacts negatively people's welfare, not only because it disturbs the daily activities, but mainly because it has a direct impact on, both physic and psycho health. In economics terms it produces an injury function (Navrud, 2002). In environmental economics two are the approaches to economically quantify such an injury: revealed preferences and stated preferences.

Stated preferences try to find the equivalent or compensatory variation associated to changes on welfare level. So, it tries to extract people's willingness to pay (WTP) when the utility level increases as a consequence of an environmental improvement (e.g.: noise reduction). On the contrary willingness to accept (WTA) is used to asses a reduction on utility level produced by an impoverishment of environmental quality. In the family of stated or declared preferences contingent valuation (CV) is the most popular technique (Riera, 1994). CV emulates a hypothetic market where public goods or services (like silence) are traded, in this market, researchers offer a change on environmental quality (e.g.: an eventual reduction of 10 dB A of street noise), and try to find the WTP for said improvement. Frequently, practitioners and researchers have a skeptical opinion about the hypothetical foundations of the method, arguing that people may not have the same behavior when are confronted to real decisions; nevertheless the Blue-Ribbon Report of the US National Oceanic and Atmospheric Administration has dissipated some economical doubts, amending its use, in the environmental economics framework. Nonetheless in the case of noise evaluation the CV has not been fairly applied. Theoretically, WTP or WTA allows calculating the marginal utility of the good or service assessed. Since CV deals with a hypothetic market it results highly versatile and can be used to evaluate real or potential projects. Besides CV allows to find directly the marginal utility of non-use values (opportunity, existence, permanence) which simply cannot be estimated by means of other methodologies. As it is evident in order to implement a CV study it is necessary to make a statistically representative sociological survey. After having collected people's WTP or WTP data can be econometrically analyzed in order to find the marginal value of noise annoyance.

The revealed preferences are the alternative family used to assess the value of public goods and services. Belonging to this family is the hedonic price method (HP), which is the most used. HP is based on the assumption that market value of private goods or services internalize the value of environmental goods or services. Using econometric techniques it is possible to infer the marginal value of environmental goods, when all the other attributes that influence market prices are suitably controlled. Normally the real estate prices, and namely the residential prices, are used when evaluating the impact of noise on quality of life. Since it is assumed that willingness to pay for houses trades off the environmental quality, in order to maintain the same utility level among residents and locations.

As it has been exposed both methodologies deal with the same aim, that is, to find the economic value that compensates the change on the welfare level produced by a level change

on the provision of public goods or services. Nevertheless these approximations do have some important differences, see for example Brookshire *et al*. (1982).

2. The Barcelona's airport enlargement.

At 1994 begun the plans to expand the Barcelona's metropolitan airport; after some alternatives proposed to decentralize empowering or creating a new air platform elsewhere did not succeeded, the final decision was to enlarge the original infrastructure settled in the neighbor municipality of el Prat de Llobregat. After several options were evaluated the Commission, settled to manage the enlargement project, decided to build a new runway parallel to the largest original, as well as a new terminal building. This new runway was located in the extreme south position, as far as possible, from the largest original runway, in order to allow a simultaneous functioning, and consequently, to maximize in number the landings and takes offs.

The original landing and take off air corridors were designed without considering the opinion of local residents; the said approach corridor invaded partially the residential surrounding areas. Nevertheless the protests were in increment, as the negative effects produced by the increase of noise were patent. As a consequence in October 2004, after the new runway aperture, a global and temporal (until 2012) agreement between the Commission and local agents was reached. This negotiation agrees the use of runways in a different way as it was originally planned. Firstly the independent use of runways (each runway is used to land and take off independently) was substituted by a segregated use (one runway is used to land and the other to take off), which according to experts may reduce the planned number of travelers. Secondly air approach corridors were modified, as a matter of fact, in the most usual configuration; planes taking off by the new runway do turn 60º to the right (towards the sea) as soon as they take off.

Social mobilization again the negative effects of airport enlargement derivate in the radicalization or creation of new local associations representing resident's interests. A number of them have been highly active in the formulation of the current configuration. Some independent studies carried out by such associations have argued that noise levels reached up 100 dBA in terms of instantaneously measurement. *In this revolted context we tried to find what the willingness to pay (WTP) of residents was in order to benefit from an eventual noise reduction*.

2.1 The good assessed and methodological approach.

Since air corridors configuration changed slightly after opening the new runway in September 2004, this evaluation is complex. The good assessed can be defined as "*the noise level*

increased between 2004 and 2006 (when temporal agreement was reached) and the eventual risk that it may increase again when, in 2012, the configuration agreement ends". As it can be observed what we try to asses is a real change and a potential one. Nonetheless, the residents surveyed were exposed to the noise levels evaluated.

In VC it is necessary to offer a potential change in the quality of environment. In this case, what has been proposed is an eventual reduction of noise levels to those experienced before the 2004's enlargement. For this reason it is necessary to offer a provision vehicle, in this case, we offered the construction of a new runway orientated not to the residential areas, but to the sea. With this infrastructure the current taking offs may be redirected out from the residential areas, reducing, as a consequence, noise levels. After exposing the provision vehicle and the potential benefits, it is necessary to extract the WTP. In this case it was argued that the cost of the new infrastructure would be paid by national, regional and local authorities. Specifying that local authorities would collect such founds from residents, using specific fees.

In the literature the use of CV in the assessment of noise impact has been, as commented before, very limited. According to Navrud (2002) one the pioneering studies was carried out by Opschoor in 1988 in Switzerland, in 1995 Thune-Larsen studied, using CV and Conjoint Analysis (another stated preferences method), the noise impact on Oslo's residential surroundings. In the Paris Orly airport Faburel (2002) found, using CV applied to 607 persons, that WTP was explained by the stated annoyance, but also WTP increased when surveyed people lived in detached houses; other aspects influencing WTP were the income level and disinformation about the problematic associated to the airport noise. Feitelson *et al.* (1996) have carried out a comprehensive study in three cities (not specified in their paper), they found that NDSI adopted values of 2.4%-4.1% for proprietors, and 1.8-3.0% for renters. NDSI is the acronym of Noise Depreciation Sensitivity Index designed by Walters (1975). This index measures the impact on real estate prices of each unit of noise level. A NDSI equal to 1% means that price decreases an average of 1% for each point that noise increase (e.g.: dB.). Recently, Bristow & Wardman (2006) have found that WTP vary according to the nuisance level experienced along the week. So, annoyed people affected by weekend and night noise have a higher WTP. A novelty methodology based on the happiness self-perceived of respondents has been recently suggested by Van Praag and Baarsma (2005). According to them, after controlling the subjective conditions of residents, the perceived condition in terms of happiness, may be linked to environmental quality of life, included the airport noise nuisance. When the Barcelona's airport was going to be expanded, Riera and Macian (1999) studied the only, as far as we know, CV study for this case. According to them only 16% of 800 total surveyed people, along Barcelona's Metropolitan Region, agreed to compensate households affected by airport enlargement. In terms of 2007 Euros, respondents stated, as an average, a compensation of 1.266 Euros for household.

The survey was structured, as suggested by Barreiro *et al.* (2005), in three sections:

1. Firstly some questions were launched in order to recall people's experience with general and airport specific noise.

2. Secondly the offered reduction of noise level was explained as well as the provision vehicle. After so, WTP was extracted. In the case that respondents were no WTP they were asked to motive their decision. This latter information was, in the analysis, used to identify protest answers[1] from true zero values.
3. Finally, some questions about the social, economic and living conditions of people allow having complementary information to be used in the analysis process.

The WTP started in a given value, and if it was accepted, respondents were asked if they were WTP more or less that a higher value (in the negative case, they were asked if they were WTP more or less than a lower vale), the final value opinion was open. So, we follow a double bounded method with open end. Besides WTP we used a complementary approach, it consisted in asking people about their hypothesis about dwelling price variation in the case that a noise reduction may take place.

2.2 Results.

After validating the information we had 492[2] valid surveys, from this total 309 stated their WTP (including true zero values), so 183 people protested (37.19%). According to this 309 valid surveys average WTP is 8.95 Euros/person/month. In order to find the marginal value of an increment of one level of noise annoyance the following model (1) was adjusted.

$$WTP = B_o + \sum_{i=1}^{n} B_i X_i \qquad (1)$$

At (1) *B* is the adjusting value of the *X* covariable *i,* being B_0 the model's constant. Such covariables are information related to people's noise annoyance, income, and other environmental qualities (which were transferred from Census Tract information using a GIS). The best model is MOD-DDP 3, is able to explain up to 33% of the WTP, and it suggests that on the explanation of WTO significant factors are:

1. Respondent's stated noise annoyance level (ordinal value adopting a scale from 0 to 10)
2. Respondent's, household income level
3. The presence of other noise sources on respondent's neighborhood
4. The fact that respondents live in the area controlled by local resident associations
5. The respondent's real estate revalorization hypothesis.

[1] In a protest answer respondent do not reveal his/her WTP because he/she does not agree the survey, may be because he/she thinks that other should pay or because the proposed provision vehicle is not reliable.

[2] People surveyed were those that at least have 3 years living in the affected area and with at least 18 years.

According to *B* values WTP increases 0.307 Euros/person/moth as noise nuisance increases each steep. Nonetheless if the resident's house lays at the proximity of a motorway (dichotomy variable), the WTP is reduced 15.17 Euros/person/month; this suggests that noise airport importance has a relative significance: when there are not other sources, it becomes important for people. Other significant finding is the influence that it seems exert the belonging to an associative area. This latter finding suggests that beyond personal injury, the WTP is a social construction where *social imaginary plays an important role on the judgment and assessment of localized prejudices* that may bias the CV analysis.

Table 2 WTP explicative model

		MOD-DP1	MOD-DP2	MOD-DP3	MOD-DP3 GWR
Constante	B	0,649	0,903	1,006	
	sig.	0,544	0,392	0,339	+
Niv_ingresos	B	1,51E-04	1,30E-04	1,03E-04	
	sig.	0,000	0,000	0,002	+
Mol_vol_son	B	0,513	0,469	0,307	
	sig.	0,000	0,000	0,027	
Zona_asociaciones	B		2,622	2,146	
	sig.		0,003	0,016	+
Presencia_autopista	B			-15,176	
	sig.			0,012	+
Revalorización	B			1,04E-04	
	sig.			0,000	+
R^2		0,215	0,244	0,322	0,497
N		239	239	221	222
F		33	25	20	1,613
Sig.		0,000	0,000	0,000	0,000
Residuos		7.916	7.624	6.235,0	4.633

Variable explicada: disposición mensual a pagar por reducir el ruido a los niveles anteriores a la ampliación del 2004
Casos excluidos DP=> med + 2 desv est
Procesamiento por pasos sucesivos

Model MOD-DP3 GWR is a not parametric function that uses a geographical weighted regression approach. When WTP is locally weighted regressed, explicative performance increases up to 49%.

3. The Barcelona's centre noise problem

In this case relevant population was Barcelona's municipality residents, using a sample of 405 valid surveys; the general noise impact was assessed. Respondents were enquired on a face to face mode in all the Barcelona's districts. The environmental improvement offered was, again,

a change tangible for people, it consisted in having a noise reduction equivalent to "reduce the noise from a level typical at a working day at a rush hour (e.g: Wednesday at 19:00 hrs) at an inferior level like that typical at a working day at 21:00". As it can be observed, people can easily recognize the change, since it is concrete and recall their daily experience with general urban noise. *Nonetheless, this approach does not permit to find a specific value for a change equivalent to 1 dB, since noise reduction for this period of time varies considerably along city.* The provision vehicle offered was a package of public policies and infrastructures sharing a common target: to reduce of environmental urban noise. Such a package included: changing the asphalt road using special sonic pavements, installing sonic shields (both natural and artificial), putting some intraurban motorways underground and the optimizing the traffic flows. In order to reduce protest answers, it was argued that such an initiative was a European Guideline, to be implemented by city councils and founded with the support of specific fees charged to residents as special taxes. After offered the potential welfare change, and explained the project and funding strategy, people were asked to state their willingness to pay, using the same iterative approach than in the cause of the airport. Beyond WTP another qualitative ordinal valuations were implemented (e.g.: respondents stated the relative importance of silence as a locative residential factor).

3.1 Results.

64% of respondents stated to be highly annoyed by urban noise. Also, almost an a half (50.6 %) said that noise level would be an important locative factor on their residence election. As a matter of fact, the rho Spearman (0.36; sig.0.000) suggest a correlation between the respondent's noise nuisance and the importance of silence as a locative factor. The higher is the nuisance the higher is the relative importance of noise on place election. As show in Table 3, respondents said that noise nuisance is in the 6^{th} place among a set of 11 locative factors offered.

Table 3 Noise nuisance and relative importance of locative factors in the residence election (0=not important, 4= very important)

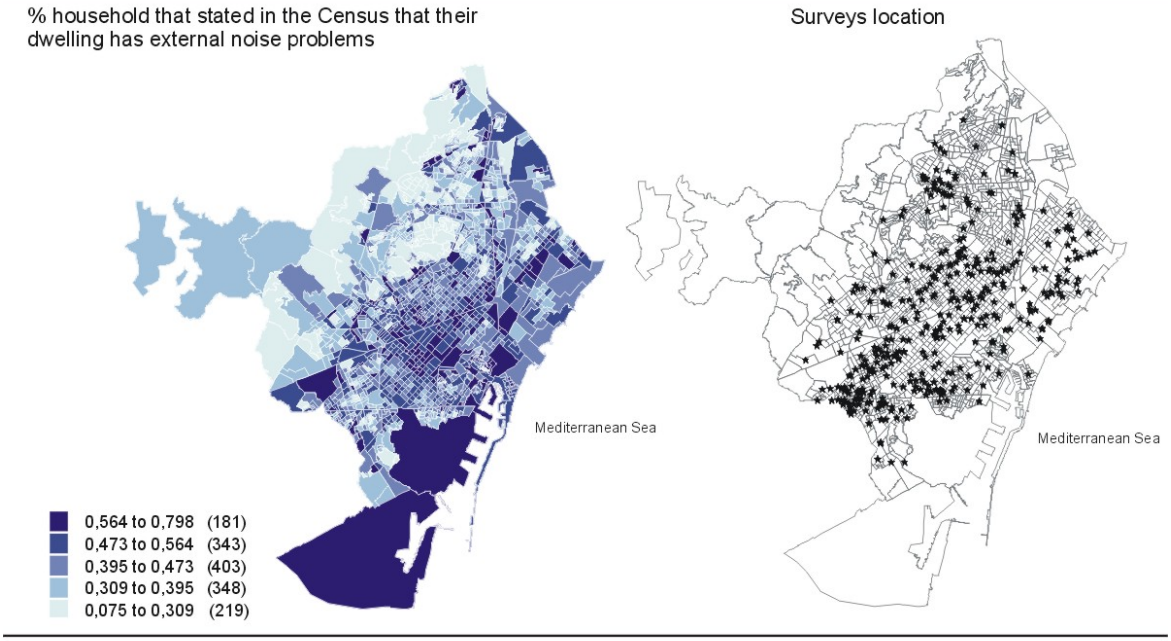
		Noise annoyed		Test ANOVA	
	general ranking	No	Yes	F	Sig.
Proximity to subway or train station	3	3,2	3,2	0,00	0,98
Good road communication	4	3,2	3,1	0,57	0,45
Presence of parks and facilities	5	3,0	3,2	5,94	0,02
Good quality and conservation of urbanization	7	3,0	3,1	0,80	0,37
Presence of retail in the area	9	2,9	2,9	0,15	0,70
Presence of pubs and restaruants	11	2,0	1,9	0,83	0,36
Public safety	1	3,4	3,5	1,79	0,18
Social prestige	10	2,3	2,2	0,57	0,45
Absence of nuisance noise	6	2,9	3,2	5,44	0,02
Proximity to heathcare centres	8	2,9	3,0	0,03	0,86
Abscence of industrial premises	2	3,3	3,4	1,49	0,22

Source: own elaboration

When not noise annoyed people answers are compared to noise annoyed people emerge important differences according to the Test ANOVA, (which detects statistical significant differences). Firstly for annoyed people the importance of silence is slightly higher than for not annoyed, as a matter of fact, for annoyed people noise absence is in 5th place of importance; secondly, noise annoyed people rates lowly the good road communication and highly the presence of parks and facilities (which are rarely important source of noise). This information may be indicative that annoyed people live in proximity to main avenues and roads, which are the main source of noise produced by vehicular and pedestrian traffic, and would prefer to live in a more friendly noise environment.

In this case 110 people protested (a global rate of 27%), this rate is lower than that observed in the noise airport assessment, and similar to other CV studies. Mainly, protest responses said that sonic problems should be financed by noise producers and not by general population; also said that general taxes should cover the expenses of noise abatement. Respondent's WTP for offered noise reduction averaged 3.39 Euros/person/month (true zeros included). In order to find the decisive factors on the WTP formation, an econometric model was used. In order to get contextual information each response was georeferenced (in the place of residence) in a GIS platform and using a buffer of 300 meters of radius information at tract level from the 2001 Census was endorsed. Such information is referred to socioeconomic (income proxies, education, percentage of households that stated that their dwelling has external noise problems) and housing data, the number of premises for economic activities and housing features). Figure 1 depicts the distribution of households annoyed by external noise level at census tract level. As it can be observed, central areas (namely El Example) together to industrial and road areas are the most affected by urban noise.

Figure 1 Noise annoyance according to National Census (2001)



Source: Population, Housing and Premises National Census (2001) and own survey

The following (2) semilog function was used.

$$LnWTP = C + \sum_i^n B_i X_i \qquad (2)$$

In (2) the natural log of monthly willingness to pay is a function of particular respondent's characteristics (income, education, stated noise prejudice, age, sex); living conditions (acoustical insulation, stated noise exposure) an other covariables, extracted both from the survey sample and from National Census. According to model 7 reported at Table 4, it is possible to explain 0.43% of WTP using the above specified variables. Such a model suggest that WTP increases as noise annoyance level, stated by respondents, increases; as well when respondents do think noise is a negative agent affecting health, WTP increases. As importance of silence, as a residential locative factor increases also do increase WTP. Income, as expected, has a positive impact on WTP. When respondents stated that their dwelling were insulated WTP increase, this finding may be interpreted contradictory, since it seems that those respondents are less exposed to external noise; nevertheless, it is probably that such insulation is not casual and respond to adverse noise environmental conditions[3].

[3] Also this specific insulation level may be associated to new and expensive dwellings, for that reason it may be interpreted as a respondent's income level.

Table 4 WTP explanatory model

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
7	,663(g)	0,439	0,43	0,65

h Dependent Variable: LNDAP

ANOVA

Model		Sum of Squares	df	Mean Square	F	Sig.
7	Regression	90,86	7	12,98	31,11	0,000
	Residual	115,98	278	0,42		
	Total	206,84	285			

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta	B	Std. Error
7	(Constant)	- 0,42	0,18	-	2,31	0,022
	Noise nuisance level	0,32	0,04	0,44	9,01	0,000
	Prejudice about noise	0,42	0,12	0,17	3,40	0,001
	Importance of silence on residential chose	0,13	0,05	0,13	2,53	0,012
	White collar worker	0,26	0,09	0,13	2,77	0,006
	Aluminium insulated windows	0,22	0,08	0,13	2,81	0,005
	Age above 64	- 0,29	0,13	- 0,10	- 2,21	0,028
	Importance of manufacture premises on residential chose	0,09	0,04	0,10	2,00	0,047

Stepwise processed

It is worthy to say that the negative sign of age-above-64 years should be interpreted as an income indicator rather than a symptom of acoustical sensibility (*presbycusis*).[4] Finally, the results suggest that the higher is the importance of the absence of industrial premises on the locative residential election, the higher is the WTP.

Final remarks.

As local and long haul mobility increases in contemporary metropolises the impact of noise on quality of life is progressively evident. This problem is particularly important in compact cities,

[4] When age and noise annoyance are correlated, there is a negative relation; since elderly people has a reduction on acoustical perception, especially in certain frequency spectrum. According to the US National Institute of Deafness and Other Communication Disorders between 30 and 35 percent of people between 65 and 75 years have a reduction of the acoustic perception; such percentage rises up to 50 % for people of 75 years and above. Nevertheless, in a multiple regression approach, noise sensibility is controlled, so the left effect of Age should be interpreted as a income level, which is reduced after jubilation.

where besides traffic; public spaces are intensively used, affecting the comfort and health level of mixed uses buildings, namely residents. This is the case of the centre of Barcelona's metropolitan area.

After the publication of the OCDE's "Fighting Noise in the 1990s Report" (1991) noise abatement has entered in the public policy agenda. Nonetheless noise abatement is a costly issue, particularly for some specific noise sources as airport, where the problem is complex because the source changes in spatial terms (reconfiguration of aerial corridors) and temporal terms (traffic increment). *The keystone on the design of public policies against noise is the appraisal of potential benefits; it is to say the social value of silence*.

Environmental economics is the theoretical framework that supports the use of two extended techniques used to assess the value of non market goods or services as it is silence. Hedonic prices and contingent valuation try both to find the marginal utility of environmental assets. Using the willingness to pay (WTP), or the willingness to be compensated (WTC), VC tries to find the compensatory or equivalent variation that allows recovering the subject's utility level in environmental quality variation scenery. In this context VC uses sociological surveys as a way to collect information and econometric models as an interpretation tool.

In this paper we have used (CV) to find the marginal value of silence in two contexts: the first in order to evaluate the acoustical impact of Barcelona's airport enlargement over residential surrounding, and the second to evaluate a hypothetical reduction of general urban noise at Barcelona municipality.

In the airport experiment the respondents WTP averaged 8.95 Euros/person/month. Econometric models, built on survey information and contextual information derived from socio-demographics, suggest a positive correlation between WTP and: income level, noise annoyance produced by airport, and the fact that respondents live in the spatial ambit of neighborhood associations against airport enlargement's negative effects. At the same time there is a negative association between WTP and the presence of other sources of urban noise, as motorways, which suggest a trade off, between the importance of airport noise and other sources. Those results are coherent with theory and reveal a important impact of social perception on the formation of WTP, since everything equal, WTP increases when people is gathered in activist associations, which may bias the CV.

In the case of general noise WTP average 3.39 Euros/person/month, for a proposed noise reduction equivalent to "reduce the noise from a level typical at a working day at a rush hour (e.g: Wednesday at 19:00 hrs) at an inferior level like that typical at a working day at 21:00". This WTP equals to 0.28% gross familiar income, such a result is practically the same that the reported by Barreiro *et al.* (2005) derived from a CV study applied at Pamplona (also in Spain).

It is necessary to explore in detail more efficient appraisals in order to have effective tools in the valuation of potential benefits of public programs designed to fight the urban noise.

Bibliography.

BARREIRO, J., M. **SANCHEZ**, and M. **VILADRICH-GRAU**. 2005. How Much are People Willing to Pay for Silence? A Contingent Valuation Study. *Applied Economics.* 37(11), pp 1233-1246.

BRISTOW, A. L. and M. WARDMAN. 2006. Valuation of Aircraft Noise by Time of Day: A Comparison of Two Approaches. *Transport Reviews.* 26(4), pp 417-433.

BROOKSHIRE, D. S.*, et al*. Valuing Public Goods: A Comparison of Survey and Hedonic Approaches. *The American Economic Review. 1982,* 72(1), pp 165-177.

FABUREL, G. 2002. Évaluation Du Coût Social Du Bruit Des Avions. Application De La Méthode d'Évaluation Contingente Au Cas d'Orly. *Les Cahiers Scientifiques du Transport.* (42), pp 43-74.

FEITELSON, E., R. **HURD**, and R. **MUDGE**. 1996. The Impact of Airport Noise on Willingness to Pay for Residences. *Transportation Research Part D: Transport and Environment.* 1(1), pp 1-

GARCÍA, B. & **GARRIDO**, F. La contaminación acústica de nuestras ciudades, *Colección Estudios Sociales,* Núm. 12. Fundación La Caixa, 2003, Barcelona.

NAVRUD, S. Economic benefits of a program to reduce transportation and community noise—A contingent valuation survey. In*: Proceedings of Internoise 2000*, 200, Nice.

OCDE, 1991. *Fighting Noise in the 1990s*. OCDE, Paris.

RIERA, P. *Manual de Valoración Contingente*, Instituto de Estudios Fiscales, 1994, Madrid. Disponible en línea: http://selene.uab.es/prieram/papers.htm [Consulta: 18/3/08]

RIERA, P. and M. **MACIAN**. 1999. Análisis Coste-Beneficio De La Ampliación Del Aeropuerto De Barcelona Con Externalidades Ambientales. Ruido, Polución Atmosférica y Ocupación De Humedades. *Estudios sobre la Economía Española.* (47), 19

VAN PRAAG, Bernard M. S. and B. E. **BAARSMA**. 2005. Using Happiness Surveys to Value Intangibles: The Case of Airport Noise. *The Economic Journal.* 115(500), pp 224-246.

WALTERS, A. A. 1975. *Noise and Prices*. Oxford University Press, London. pp 147 p.